Comprehensive assessment of water management in agriculture

water for food, water for life issuebrief#6

Investing in irrigation:

Why, how, and how much?

Irrigation has reduced poverty, catalyzed economic growth in rural areas, and supplied burgeoning populations with affordable, high-quality food. However, these benefits have often come at considerable cost—both financial and environmental.

While irrigation will continue to be critical to meeting global food needs and to reducing poverty in some areas, the conditions that led to massive public investment in large-scale irrigation in the latter half of the twentieth century have changed.

Investments in irrigation are still needed (see Box 1) but must become more strategic. This means looking at irrigation in the context of other development investments; taking into consideration the big picture of costs and benefits, including social, cultural, economic, and environmental aspects; and considering the full spectrum of irrigation options—from large-scale systems providing water for all or most of the crop's needs to small-scale technologies supplying water to bridge dry spells in rainfed areas (see Box 2).

Box 1: Four reasons to invest in irrigation

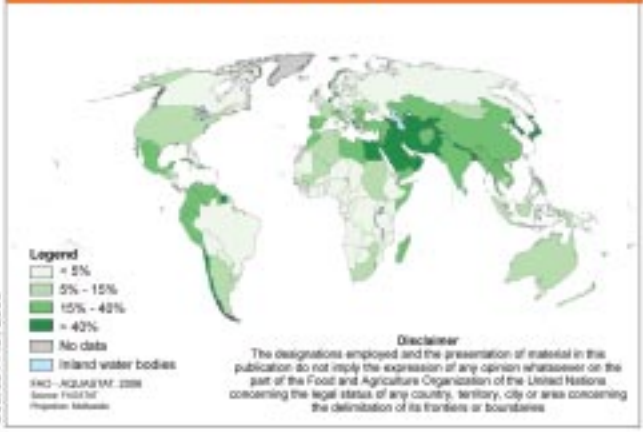
To reduce rural poverty - In countries and regions that rely on agriculture for a large portion of their GDP (this includes most of sub-Saharan Africa), increased agricultural productivity is the most viable option for poverty reduction. Here irrigation development can act as a springboard for economic development.

To keep up with food demand and changing food preferences - Feeding an additional 2 billion people by 2025 and will require greater productivity on existing irrigated lands, as well as some degree of irrigation expansion.

To adapt to changing conditions - Increasing competition for water will require investments that enable farmers to grow more food with less water. Increasing climate variability and extremes, due to climate change, may require further irrigation development and changes in the operation of existing schemes.

To increase multiple benefits and ecosystem services from existing systems, while reducing negative impacts (see Brief #1 of this series).

Fig. 1. Irrigated areas as a percentage of cultivated area by country



Source FAO, 2006

Why invest in irrigation?

Reducing poverty and spurring economic development

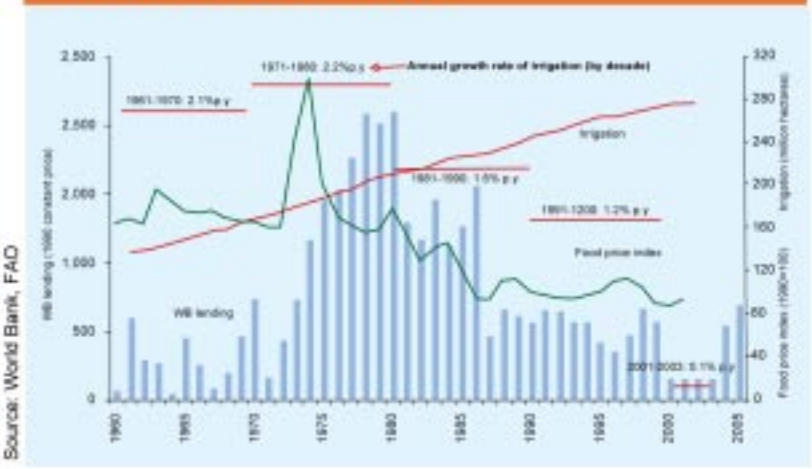
Irrigation improves farmer incomes—by boosting yields, by enabling increased cropping intensity, by reducing vulnerability to droughts and dry spells, and by giving farmers the water security they need to risk investing in fertilizer, higher-yielding varieties, and other productivity-enhancing inputs. Recent studies in India found that access to irrigation and education have been the two main contributing factors to reducing rural poverty, as well as improving agricultural productivity.

Irrigation also offers a number of secondary benefits for poverty and hunger reduction. The drop in staple food prices made possible by irrigation has benefited both the rural and the urban poor, who spend a significant portion of their income on food (see Figure 1). In rural areas, irrigation stimulates the demand for agricultural labor. For example, the annual labor work per hectare in the Ganges-Kobadak irrigation system in Bangladesh is around 100 days more than in nearby non-irrigated areas. In addition, irrigation development galvanizes local agro-enterprises and the agricultural sector as a whole—increasing its contribution to the national economy. The overall multiplier effect for irrigation has been estimated at between 2.5 and 4.

On the other hand, while irrigation has reduced poverty on the whole, benefits have often bypassed the poorest. Many large-scale irrigated areas, particularly in India and Pakistan remain home to large numbers of poor people in both absolute and relative terms. In some cases, irrigation development has actually had a negative impact on women and on the poorest segments of society—when projects have displaced them, barred them from accessing natural resources they depended upon, or otherwise degraded those resources.

So what determines the poverty-fighting impact of irrigation investments? The biggest determinant is, not surprisingly, the degree of equity in access to land and water resources. But several other factors also play a role, including the type of irrigation; access to information and input and output markets; cropping patterns, production technologies and practices; and the existence of favorable broader water and agricultural policies.

Fig. 2. World Bank lending (bars) for irrigation and drainage, area under irrigation and world food price index (of 1990 constant US$)



Source: World Bank, FAO

Investments in irrigation, together with other components of the green revolution package, such as the introduction of improved crop varieties and substantial growth in fertiliser use, particularly in Asia, led to a steady increase in staple food production and contributed to the reduction of real world food prices.

Meeting future food demand

To feed the some two billion more people who are expected to swell the global population in the next 25 years, agricultural production will need to increase by 45%. Irrigated agriculture currently supplies 40% of the world's food; by 2030, this share is expected to increase to 45%. Much of this increase can come from improved productivity on existing irrigated lands. This requires investments in modernization and improved water control—on top of the investment needed to simply maintain the functionality and safety of existing irrigation infrastructure.

Changing dietary preferences also influence the need for irrigation. With increasing incomes and urbanization in many developing countries, diets are shifting from staples to fruits and vegetables, which are generally more sensitive to water stress and therefore demand a more reliable water supply. Greater access to export markets also spurs investments in irrigation to improve product quality, raise yields, and enable production of "luxury" goods such as wine.

Adjusting to water scarcity and other challenges

But, as competition for water from other sectors intensifies, irrigation will increasingly be under pressure to release water for higher value uses—to grow more food with less water. In addition, climate change may mean changes in rainfall distribution and variability, higher temperatures, and more extreme weather events. To adapt to these changes will

require increased water storage capacity and new reservoir operating rules, which will include, in some cases, difficult tradeoffs between environmental and agricultural water allocations.

What kind and how much?

In some areas there is scope for expanding irrigation; in others the challenge is to get more from existing infrastructure—through technical upgrading and promoting better management practices.

The challenge for irrigated agriculture in the next century will be to improve equity, reduce negative environmental impacts, increase ecosystem services, and enhance water and land productivity in new and existing irrigated systems. There is a palette of investment options that require different types of approaches and support. Countries will need to tailor irrigation investments more closely to particular circumstances—reflecting the stage of national development, degree of integration into the world economy, land and water resource availability, share of agriculture in the national economy, and comparative advantage in local, regional and world markets (see Table 1).

Box 2: Types of irrigation investment

Most people associate irrigation investments with large public expenditures to develop new irrigation systems (capital investment). The CA takes a broader view—one that includes investments in building knowledge and capacity as well as infrastructure; and in making water governance and institutions, as well as irrigation systems, more efficient and responsive to changing needs and contexts.

It is a view that considers the full spectrum of irrigation possibilities—from systems that provide full irrigation to small-scale technologies that provide supplemental irrigation to bridge dry spells in rainfed areas. It includes everything from traditional canal-based, surface schemes; to groundwater development; to use of urban waste water for peri-urban farming; to water harvesting coupled with small-scale technologies (e.g. low cost drip kits).

Finally, it is a view that looks at the roles of different kinds of investors—governments and donors, but also private companies, communities, and individual farmers.

Table 1: Focus for investment by type of irrigation system

This table provides examples of areas for irrigation-related investment in three types of systems, with reference to different stages of economic development.

System Type	Category	Agricultural economy, large rural population	Transition	Industrial, market-based economy
Large scale, public irrigation systems, both in dry and humid areas	Policy Focus	Integrated rural development	Linking water and agriculture policies	Implementing IWRM approach
	Capital investment - water	Small and large dams; gravity irrigation development; on-farm groundwater development		Upgrading of irrigation and drainage infrastructure
	Capital investment - others	Rural infrastructure; roads; markets; social and health infrastructure; electrification		Upgrading rural infrastructure
	Regulation	Land tenure and water rights; stakeholder involvement in scheme management	Water rights; local institution regulations; participatory irrigation management	Irrigation management transfer
	Management	Increase reliability in system operation	Restructuring; improved accountability and transparency; improved system control and operation; enhanced flexibility of water service; enhancing system multifunctionality	
	Capacity building	Training of irrigation staff and farmers; WUA formation and strengthening		Strengthening of professional organizations; market information systems
	Finance	Term finance; rural credit and micro-credit; grant	Term finance; agricultural savings and loans	Commercial financing
	Technology	Land leveling; shallow wells; small scale pumping technology; conjunctive use of surface water and groundwater		Commercial financing
Small-medium scale, community-managed systems	Policy Focus	Integrated rural development	Linking water and agriculture policies	
	Capital investment - water	Run-off river; weirs, diversion; local storage and small dams	Local storage and small dams; improved water distribution infrastructure	
	Capital investment - others	Rural infrastructure, roads; market access and information; social and health infrastructure; electrification		
	Regulation	Water rights, including traditional water rights	Recognition & formalisation of water rights & bulk water allocation	
	Management	Conflict management; on-farm water management		
	Capacity building	Training of extension staff; WUA information and empowerment	WUA monitoring and support; staff training	
	Finance	Grants; targeted subsidies	Rural finance	
	Technology	Small scale micro-irrigation systems; tanks	Mechanised agriculture; deep tubewell drilling; pressurised irrigation systems	
Farm scale, individually managed systems for local market	Policy Focus	Food safety, food security and nutrition policies		
	Capital investment - water	Shallow well drilling; canals		
	Capital investment - others	Market and infrastructure development	Rural electrification; energy pricing	Market and infrastructure development; wastewater treatment
	Regulation	Tenure security; water rights; food safety control		Tenure security; food safety control, environmental control
	Management	Wastewater re-use		
	Capacity building	on-farm water management and food and water quality control		
	Finance	Micro-finance		
	Technology	Low cost, robust irrigation technology	Mechanised groundwater use	Water measurement and control; automation; low pressure irrigation

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In places where poverty reduction remains a priority for rural development, irrigation strategies must be designed to address the needs of poor farmers–e.g. small-scale technologies; supplemental irrigation; and water supply systems that provide water for multiple uses. Reforms in policies and practices to increase equitable access to land and water, transparency and accountability to the user, and access to inputs and markets, can all help ramp up the poverty-fighting benefits from existing schemes. Investments in new irrigation development should be part of larger rural development strategies—with complementary investments in roads, communications, and other supporting infrastructure which enhance market access and information flows.

To grow more food and with less water will require complementary investments in improved technologies, management practices, and supportive policies. In particular, investments in modernization and improved water control are needed. Infrastructure for water treatment and conveyance, along with regulations and management practices, to support reuse of urban and industrial wastewater is another area of investment. Greater flexibility and reliability in irrigation service are needed for farmers to take advantage of changing market imperatives.

While investment in most countries will be directed at getting more from existing irrigation infrastructure, there will be some degree of irrigation expansion—where water availability and national priorities support it. The Food and Agricultural Organization of the United Nations predicts that irrigation will continue to expand through 2030 in developing countries, although at a much slower rate than before—by 0.6 percent per year from 1997 to 2030 as compared to 1.6% per year from 1960 to 1990. Table 2 provides estimates of future expansion of irrigated land and investments in new development and rehabilitation.

Box 3. Irrigation's report card: Why hasn't it always reached its potential and how can we learn from past mistakes?

Differing opinions exist, even among experts, on irrigation's overall performance. In an evaluation carried out by the Operation and Evaluation Department of the World Bank, 67 percent of Bank-financed irrigation projects from 1961 to 1987 rated satisfactory overall, with an average internal rate of return of 15%.

However, it is difficult to deny that many systems perform below their design expectation and present serious sustainability challenges. In addition, there are significant cases of failure of "large-scale" irrigation schemes. In sub-Saharan Africa, for instance, approximately 18% of land developed under irrigation is not used, and in many Asian countries, there are large amounts of unused irrigable land.

What are the reasons for irrigation's "underachievement"? Some common ones to keep in mind include:

- Corruption and rent-seeking—resulting in, at best, higher project costs and lower economic returns on irrigation investments and, at worse, unsustainable systems that are not feasible in technical or economic terms.
- Inadequate financial resources for operations and maintenance and for drainage.
- Planning and design flaws, often leading to non-functioning systems, unreliable water supplies and excessive management complexity.
- A bias towards infrastructure investment to the neglect of capacity-building (for farmers and irrigation service providers) and institutional strengthening.
- Non-water-related constraints, such as lack of access to market or credit and land tenure favoring absentee landlords.

Table 2: Projection of capital investment needs by region in irrigation development and rehabilitation in 93 developing countries (1998-2030)

Region	Irrigated area ('000 ha)			Unit cost (US$/ha)		Total cost (million US$)		
	1998	2030	Δ (%)	New	Rehab.	New	Rehab.	Total
East and Southeast Asia	71 500	85 300	19	2 900	700	40 000	46 400	86 500
Latin America and Caribbeans	18 400	22 000	20	3 700	1 300	13 400	23 900	37 300
Near East and North Africa	26 400	33 100	25	6 000	2 000	40 100	52 800	92 900
South Asia	80 500	95 000	18	2 600	900	37 600	68 500	106 100
Sub-Saharan Africa	5 300	6 800	30	5 600	2 000	8 900	10 500	19 400
Total	202 000	242 200	20	3 500	1 000	140 100	202 000	342 100

Source: based on FAO (2003) and Innocentio et al. (2006)

Comprehensive assessment of water management in agriculture

For more information. Email: comp.assessment@cgiar.org **Visit: www.iwmi.cgiar.org/assessment**

The Comprehensive Assessment of Water Management in Agriculture (CA) is a five-year initiative to analyze the benefits, costs, and impacts of the past 50 years of water development and management in agriculture, to identify present and future challenges, and to evaluate possible solutions. The main Assessment report *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture* is published by Earthscan (forthcoming). More on the CA donors, co-sponsors (CBD, CGIAR , FAO, Ramsar), process and publications can be found at: http://www.iwmi.cgiar.org/assessment.

The Food and Agriculture Organization of the United Nations (FAO) helps countries modernize and develop sustainable agriculture, forestry and fisheries practices, ensuring good nutrition and food security for all. As partner of the CA, FAO contributes its knowledge, information and expertise on water management in agriculture. FAO is also a sponsor of the CA, committed to transmitting its findings to its constituents.

This Brief is based on the book *Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture*, 2006 (forthcoming), Chapter: 'Reinventing Irrigation' by Jean-Marc Faurès, Mark Svendsen, Hugh Turral, Flemming Konradsen, Rebecca Tharme, Claudia Ringler, Lisa Schipper, Madhusudan Bhattarai, Robina Wahaj, Ruth Meinzen-Dick, Intizar Hussain, Thierry Facon, David Groenfeldt, Paul van Hofwegen

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